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Quarterly Technical Summary

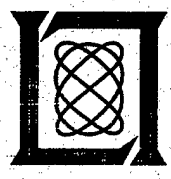
Advanced Electronics Technology

15 May 1998

Lincoln Laboratory

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

LEXINGTON, MASSACHUSETTS



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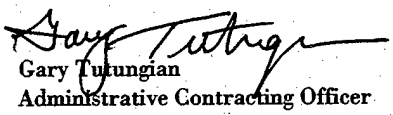
The ESC Public Affairs Office has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER



Gary Tutungian
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LINCOLN LABORATORY

ADVANCED ELECTRONICS TECHNOLOGY

QUARTERLY TECHNICAL SUMMARY REPORT
TO THE
AIR FORCE MATERIEL COMMAND

1 FEBRUARY – 30 APRIL 1998

ISSUED 25 SEPTEMBER 1998

LEXINGTON MASSACHUSETTS

INTRODUCTION

This Quarterly Technical Summary covers the period 1 February through 30 April 1998. It consolidates the reports of Division 6 (Communications and Information Technology) and Division 8 (Solid State) on the Advanced Electronics Technology Program.

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COMMUNICATIONS AND INFORMATION TECHNOLOGY
DIVISION 6

INTRODUCTION

This section of the report reviews progress on Machine Intelligence Technology during the period 1 February through 30 April 1998. Separate reports describing other Information Systems Technology work of Division 6 are issued for the following programs:

Tactical Speech Processing	AFRL/IF
Speech and Signal Processing Technology	NSA

V. W. Chan
Head, Division 6

C. W. Niessen
Associate Head

MACHINE INTELLIGENCE TECHNOLOGY
GROUP 62

1. INTRODUCTION

The objective of the Machine Intelligence Program has been the application of MI techniques to problems in the interpretation and utilization of data produced by imaging sensors. Past emphasis has been on algorithms for ISAR (Inverse Synthetic Array Radar) and SAR (Synthetic Array Radar) imaging sensors and on processors for real-time, fully-automated applications such as automatic recognition of reentry vehicles (the ISAR application) and of ground vehicles (the SAR application). The application emphasis has been shifted over the past year to concentrate on exploitation technology for visible and IR multispectral sensors, most particularly night vision research in which low-light visible and IR images are combined to create a color night vision capability. Fusion techniques have also been applied to image enhancement and color display algorithm development to facilitate analyst-based exploitation of multispectral surveillance images, and to multispectral surveillance algorithm research to develop automatic target detection algorithms for operation in complex environments. The line-supported work on night vision was completed last FY, with follow-on work on algorithms, real-time implementation, and low-light CCD sensor technology being funded by DARPA.

Motivated by the growing vulnerability of large-scale military and national information-dependent infrastructure systems to exploitation, manipulation, and sabotage, Lincoln Laboratory conducted a study during FY95 commissioned by DARPA/ITO. The study goal was to recommend technical approaches and technology-based strategies to address this situation, particularly in regard to current and future U.S. Military Communications, Command, Control, Computers, and Intelligence (C4I) systems. Also in the FY95-96 time frame, Lincoln participated in several national studies focused on these issues, including the DARPA Information Science and Technology FY95 summer study on Defensive Information Warfare, and the FY96 Defense Science Board Task Force on Defensive Information Warfare (IW-D). As an outgrowth of these efforts, Lincoln initiated in FY97 an OSD Line-supported IW-D technology development program focused on the following major aspects of this important national security problem:

- Survivable Distributed C4I Systems
- Computer/Network Monitoring and Surveillance

Work in these two areas during the second quarter of FY98 is summarized below.

2. SURVIVABLE DISTRIBUTED C4I SYSTEMS

Research on dynamic reconfiguration as a survival strategy has progressed further, and is described in an MIT MS thesis, "Survivability through Dynamic Reconfiguration," completed by Subramaniam R. Sthanu on 20 May 1998. In the thesis, he describes the use of dynamic reconfiguration as a survival strategy with distributed collaboration as a test application. Because the design and implementation of distributed information systems is so complex, it is unreasonable to expect that real

systems will be free of flaws and vulnerabilities. However, because attacks typically target specific weaknesses in software components or protocols, the system can be made more robust by giving it the ability to dynamically switch over to different software or protocols. Thus, the system can avoid the effects of an attack by dynamically reconfiguring.

For this thesis, a prototype collaboration tool was developed to demonstrate dynamic reconfiguration. The tool was implemented in the JAVA programming language and includes three collaboration components: (1) a shared drawing area, (2) a text-based chat area, and (3) voice communication. Each component uses an abstract Channel for network communication. The details of the implementation of this Channel are hidden from the component that uses it. A SwitchChannel was implemented, which allows the underlying network connection to be switched out and replaced without disrupting ongoing communication.

An abstract Configuration class establishes network connections and provides Channels for use by the components of the collaboration tool. Several different Configurations were implemented for this prototype tool. One Configuration provides unicast peer-to-peer network connections. Each member of the collaboration group has a connection to every other member of the group. Another Configuration provides unicast client-server network connections. Each member of the collaboration group establishes a connection with a central server, which forwards messages among the group members. One Configuration that was not fully implemented in the prototype is multicast. Several of the components of the tool require reliable transmission of data, and there was insufficient time to incorporate a JAVA implementation of a reliable multicast protocol.

Currently, reconfiguration is a manual process performed with the graphical user interface of a ConfigurationManager. Further research and development would be required to automate the process of detecting and reacting to denial-of-service attacks. Currently, only a few preconfigured Configurations are available and ConfigurationManagers exchange simple messages to coordinate the switching among these Configurations. Further development would be required to allow ConfigurationManagers to exchange Configurations as executable content, making it possible to dynamically install new Configurations that were not built-in to the tool.

3. COMPUTER/NETWORK MONITORING AND SURVEILLANCE

During the past quarter, we have collected and analyzed several weeks' worth of network traffic from Hanscom Air Force Base (HAFB). We had hoped that this network traffic would include all packets entering and leaving the base, with the exception of packets sourced by or destined for certain highly sensitive (but unclassified) base computers. Due to the complexity of the network perimeter, however, this has proven impossible. Therefore, we have collected traffic from a variety of access points at different times. Our attention has focused mainly on the HAFB Internet connection provided by BBN PLANET and the so-called Air Force Internet (AFIN) connection. We have also obtained detailed web access information from HAFB proxy logs. All of these statistics have been used to help generate realistic background for our DARPA/AFRL-sponsored intrusion detection evaluation.

The configuration of our preparation (*prepnet*) and simulation (*simnet*) networks is complete. The *prepnet* is used for producing and testing our software tools and simulations. The *simnet* is used for final

execution of the simulation. Network packets captured from the *simnet*, as well as audit logs from a few *simnet* computers, will comprise the evaluation corpus. We have been able to obtain and employ software from the Air Force Rome Laboratory COMSEC Engineering Branch at HAFB that allows a single computer running *Linux* (a UNIX variant) to emulate dozens of separate computers. This AFRL software allows us to simulate hundreds of computers using less than a dozen actual computers.

We have continued to create and enhance our software tools, focusing on those tools that will allow us to generate and verify the large quantity of background data required for our intrusion detection evaluation. To produce the millions of normal background sessions contained in the training and testing data, we need automated ways (1) to specify which network sessions are to run, (2) to run those sessions without user intervention, (3) to verify that each session has run correctly, and (4) to de-mark each session for the evaluation participants. Preliminary versions of software have been written to perform each of these tasks, though enhancement is ongoing.

We have produced characterizations that will allow us to simulate thousands of users such as secretaries, programmers, managers, and system administrators. Simulated actions include remote log-in, remote file transfer, web access, e-mail transactions, software development, and file manipulation. We have also defined suspicious actions by these users, in order that anomaly detectors can be adequately evaluated.

Towards the end of the quarter, we integrated all these tools and characterizations in an effort to produce four hours of simulation data containing about 10,000 normal network sessions and a handful of attacks. It is our plan to distribute this subset of data to the evaluation participants early in the next quarter.

3.1 Modeling Normal and Anomalous Usage

Some of the simulated computer session data being generated are designed to evaluate systems that detect anomalies in users' activities. To this end, several occupational identities were created, where each identity ("anomaly user") has his own pattern of normal computer activity. During some sessions, anomalous actions are introduced for these anomaly users, whereby the types of commands, frequency of individual commands, or times of log-in are changed.

The occupations being simulated currently include C programmers, managers, a secretary, and a system administrator. All the sessions are run via *telnet* connections and are sniffed to provide *tcpdump* data. BSM audit logs are also produced from the machine on which the sessions are run.

Normal activity for the programmer constitutes logging in twice a day, five days a week (via *telnet*). The times of log-in and log-out are chosen randomly each day, but the exponential probability distribution of the times remains constant within each user. One programmer works mornings and afternoons; the other works afternoons and evenings. The primary area of activity for the C programmers is to edit C programs. Using the standard UNIX text editor, "*Vi*", they edit a random number of lines of code in their current working program and save their work. They also attempt to make and execute their programs. In addition, the programmers each have a set of favorite UNIX commands they like to run (i.e., *date, ls, cat /usr/include, pwd*) and a set of manual pages they enjoy browsing (i.e., *fopen, malloc, strcat*). The programmers also send mail to other users and receive mail sent by other anomaly users and by

simulated software vendors. The users read their mail via an interactive mail reading procedure that views messages for random lengths of time and then deletes them with a prescribed probability.

The secretary spends most of his time editing documents. We are currently modeling usage of the *LaTeX* text processing system, which is a very commonly used text processor for producing technical papers. He runs *LaTeX, ghostview*, and *lpr* to view and print his papers. He also sends mail to other anomaly users and reads incoming mail.

The system administrator runs commands such as *top, ps*, and *cat /etc/passwd* and frequently changes her user identity to root. She also sends and reads e-mail.

The managers read mail they receive from other anomaly users and from vendors. They sometimes reply to the anomaly users. All users use the same mail reading procedure as described above.

All commands of the users occur with frequencies that are simulation parameters. The time intervals between successive commands are determined by exponential random variables whose means are parameters, and the probabilities of a particular user executing each of the different possible commands are also parameters. Using such a model for session activity, each anomaly user exhibits day to day variability but remains largely consistent in the nature and frequency of his commands.

The anomalies that are introduced encompass varying degrees of subtlety. Some anomalies are very slight, such as a programmer looking at many more manual pages than normal, a manager learning a new UNIX command, or the secretary receiving a mail message from a software vendor. These types of anomalies may be difficult to differentiate from the day-to-day noise that comes with the probabilistic model of command generation. Other anomalies involve failed log-ins via mistyped passwords or usernames, or failed attempts by the system administrator to log in as root. These events are typical of normal user activity if they do not persist for too long, but they, nevertheless, may be a good indicator of anomalous behavior. A more striking anomaly involves a user changing his/her daily schedule. One example of this type is if a user who every weekday logs in during the morning and again during the afternoon, logs in on Saturday night. A similar example is if a user normally has one telnet session per morning, and one morning he logs in and out many times during a short time period. An anomaly detector should be able to pick out these unusual log-in patterns. The most blatant class of anomalies that is introduced is that of a user changing identity. Examples of this type of anomaly are the secretary suddenly editing C programs and issuing all the commands of a C programmer or a programmer suddenly performing all the actions of a system administrator.

Future work in the generation of anomaly user data will focus on elaborating the activities of the different users to include a larger range of normal commands and anomalies. A mistyping function will be incorporated so that words at the command line will be mistyped in ways that correspond to normal user mistyping.

SOLID STATE
DIVISION 8

INTRODUCTION

This section of the report summarizes progress during the period 1 February through 30 April 1998. The Solid State Research Report for the same period describes the work of Division 8 in more detail. Funding is provided by several DoD organizations—including the Air Force, Army, BMDO, DARPA, Navy, NSA, and OSD—and also by the DOE, NASA, and NIST.

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Head, Division 8

R. W. Ralston
Associate Head

DIVISION 8 REPORTS
ON ADVANCED ELECTRONICS TECHNOLOGY

1 FEBRUARY THROUGH 30 APRIL 1998

PUBLICATIONS

Linear and Nonlinear Microwave Dynamics of Vortices in $YBa_2Cu_3O_{7-\delta}$ Thin Films	N. Belk* D. E. Oates D. A. Feld G. Dresselhaus* M. S. Dresselhaus*	*Phys. Rev. B* **56**, 11 966 (1997)
III-V Quantum-Well Structures for High-Speed Electronics	E. R. Brown K. A. McIntosh	In *Advances in Research and Development: Heterojunctions for High-Speed and Infrared Applications*, Vol. 23 of *Thin Films* (Academic, San Diego, 1997), p. 173
Large-Area Back-Illuminated CCD Imager Development	B. E. Burke J. A. Gregory R. W. Mountain B. B. Kosicki E. D. Savoye P. J. Daniels V. S. Dolat T. L. Lind A. H. Loomis D. J. Young G. A. Tonry	*Exp. Astron.* **8**, 31 (1998)
High-Performance GaInAsSb Thermophotovoltaic Devices with an AlGaAsSb Window	H. K. Choi C. A. Wang G. W. Turner M. J. Manfra D. L. Spears G. W. Charache* L. R. Danielson* D. M. Depoy*	*Appl. Phys. Lett.* **71**, 3758 (1997)

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Thermal Coefficients of the Optical Path Length and Refractive Index in YAG	T. Y. Fan J. L. Daneu	*Appl. Opt.* **37**, 1635 (1998)
Hall-Effect Analysis of GaN Films Grown by Hydride Vapor Phase Epitaxy	W. Götz* L. T. Romano* J. Walker* N. M. Johnson* R. J. Molnar	*Appl. Phys. Lett.* **72**, 1214 (1998)
High-Power, High-Efficiency Quasi-CW Sb-Based Mid-IR Lasers Using 1.9-μm Laser Diode Pumping	H. Q. Le G. W. Turner J. R. Ochoa	*IEEE Photon. Technol. Lett.* **10**, 663 (1998)
Efficiency and Power Issues in Sb-Based Mid-Infrared Lasers	H. Q. Le G. W. Turner J. R. Ochoa H. K. Choi C. H. Lin* S. S. Pei*	*Proc. SPIE* **3284**, 276 (1998)
Simple Compact Diode-Laser/ Microlens Packaging	Z. L. Liau D. Z. Tsang J. N. Walpole	*IEEE J. Quantum Electron.* **33**, 457 (1997)
Simple Application of the Envelope-Function Approximation for Photonic Crystals	J. P. Mattia E. R. Brown C. D. Parker	*Phys. Rev. B* **57**, 1308 (1998)
Hydride Vapor Phase Epitaxy of Gallium Nitride Films for Quasi-Bulk Substrates	R. J. Molnar W. Götz* L. T. Romano* N. M. Johnson*	*Proceedings of the First Symposium on III-V Nitride Materials and Processes* (Electrochemical Society, Pennington, N.J., 1996), p. 212

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Chemically Assisted Ion Beam Etching of Submicron Features in GaSb	G. Nagy* R. U. Ahmad* M. Levy* R. M. Osgood, Jr.* M. J. Manfra G. W. Turner	*Appl. Phys. Lett.* **72**, 1350 (1998)
Pattern Transfer for Diffractive and Refractive Microoptics	M. B. Stern	*Microelectron. Eng.* **34**, 299 (1997)
Ultralow-Threshold (50 A/cm^2) Strained Single-Quantum-Well GaInAsSb/AlGaAsSb Lasers Emitting at 2.05 μm	G. W. Turner H. K. Choi M. J. Manfra	*Appl. Phys. Lett.* **72**, 876 (1998)

ACCEPTED FOR PUBLICATION

A 1.3-GHz SOI CMOS Test Chip of Low-Power High-Speed Pulse Processing	R. Berger W. G. Lyons A. M. Soares	*J. Solid-State Circuits*
1.5-μm Tapered-Gain-Region Lasers with High CW Output Powers	J. P. Donnelly J. N. Walpole S. H. Groves R. J. Bailey L. J. Missaggia A. Napoleone	*IEEE Photon. Technol. Lett.*
Low Loss High Efficiency and High Power Diode-Pumped Mid-Infrared GaInSb/InAs Quantum Well Lasers	H. Q. Le C. H. Lin* S. S. Pei*	*Appl. Phys. Lett*
Phase Noise of a Resonant-Tunneling Relaxation Oscillator	S. Verghese C. D. Parker E. R. Brown	*Appl. Phys. Lett.*

*Author not at Lincoln Laboratory.

Overview of VCSEL Applications	R. C. Williamson	In *Vertical Cavity Surface Emitting Laser,* C. Wilmsen, H. Temkin, and L. Coldren, eds. (Cambridge University Press, Cambridge, England)

PRESENTATIONS†

Durability of Pellicles for 193-nm Lithography	A. Grenville V. Liberman R. R. Kunz, M. Rothschild, J. H. C. Sedlacek R. Uttaro C. VanPeski	
193-nm Lithography: Fundamentals and Issues	R. R. Kunz	
Durability Testing of Optical Coatings for 193-nm Lithographic Applications	V. Liberman M. Rothschild J. H. C. Sedlacek R. Uttaro A. Grenville K. Bates	23rd SPIE International Symposium on Microlithography, Santa Clara, California, 22-27 February 1998
Metrology Methods for the Quantification of Edge Roughness	C. M. Nelson S. C. Palmateer T. M. Lyszczarz	
Line Edge Roughness in Sub-0.18-μm Resist Patterns	S. C. Palmateer S. G. Cann J. E. Curtin S. P. Doran L. M. Eriksen A. R. Forte R. R. Kunz T. M. Lyszczarz C. Nelson M. B. Stern	

†Titles of presentations are listed for information only. No copies are available for distribution.

Photolithography at Wavelengths Below 200 nm	M. Rothschild	23rd SPIE International Symposium on Microlithography, Santa Clara, California, 22-27 February 1998
Low-Threshold, High-Power, High-Brightness GaInAsSb/ AlGaAsSb Quantum-Well Lasers Emitting at 2.05 μm	H. K. Choi G. W. Turner, J. N. Walpole Z. L. Liau L. J. Missaggia M. K. Connors M. J. Manfra V. Daneu P. W. O'Brien A. Sanchez-Rubio D. L. Spears	1998 Diode Laser Technology Review, Albuquerque, New Mexico, 2-4 March 1998
1.55-Micron Laser Development	J. N. Walpole J. P. Donnelly S. H. Groves R. J. Bailey L. J. Missaggia A. Napoleone	
Low-Light-Level 640 × 480-Pixel CCD Camera for Night Vision Applications	R. K. Reich B. E. Burke W. H. McGonagle D. M. Craig A. W. Waxman E. D. Savoye B. B. Kosicki	1998 Meeting of the IRIS Specialty Group on Passive Sensors, Albuquerque, New Mexico, 2-4 March 1998
Integrated Optics	L. M. Johnson	Lincoln Laboratory Technical Seminar Series, The University of Michigan Radiation Laboratory, Ann Arbor, Michigan, 12 March 1998

A Very Wideband Compressive Receiver Using High-T_C Superconductive Chirp Filters	W. G. Lyons R. Berger M. M. Seaver R. R. Boisvert P. G. Murphy D. R. Arsenault A. C. Anderson L. M. Johnson T. C. L. G. Sollner L. Oliva* W. R. Bang* R. Cecchini* P. Burke* D. Wang* A. F. Hinte*	1998 Government Microcircuit Applications Conference, Arlington, Virginia, 16-19 March 1998
Resonant-Tunneling Diode Digital Filters	T. C. L. G. Sollner J. P. Sage C-L. Chen P. A. Maki M. A. Hollis R. H. Mathews	
Properties of Grain-Boundary Josephson Junctions at Microwave Frequencies	D. E. Oates Y. M. Habib* C. J. Lehner* L. R. Vale* R. H. Ono* G. Dresselhaus* M. S. Dresselhaus*	Meeting of the American Physical Society, Los Angeles, California, 16-20 March 1998
Properties of YBCO Grain Boundaries at Microwave Frequencies	D. E. Oates Y. M. Habib* C. J. Lehner* L. R. Vale* R. H. Ono* G. Dresselhaus* M. S. Dresselhaus*	

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Laser Micromachining of Silicon: A New Technique for Fabricating THz Imaging Arrays	C. K. Walker* T. M. Bloomstein S. T. Palmacci M. B. Stern J. E. Curtin	SPIE Symposium on Astronomical Telescopes and Instrumentation Quality, Kona, Hawaii, 20-28 March 1998
Photolithography at Wavelengths Below 200 nm	M. Rothschild	Technical Seminar, Taiwan Semiconductor Manufacturing Company, Hsin-Chin, Taiwan, 23 March 1998
Transmission Electron Microscopy Investigation of Titanium Silicide Thin Films	A. F. Myers* E. B. Steel* L. M. Struck* H. I. Liu J. A. Burns	1998 International Conference on Characterization and Metrology for ULSI Technology, Gaithersburg, Maryland, 23-27 March 1998
Topics in 193 nm Lithography	M. Rothschild	First Seminar on 193 nm Optical Lithography in Taiwan, Taipei, Taiwan, 25-27 March 1998
Superconducting Electronics for Signal Processing	T. C. L. G. Sollner K. Berggren D. A. Feld W. G. Lyons D. E. Oates J. P. Sage	Technical Seminar, Princeton University, Princeton, New Jersey, 30 March 1998
Optical Sampling for Analog-to-Digital Converters	J. C. Twichell	Seminar Series on Optics and Quantum Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1 April 1998

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Photomask Materials, Processing, and Related Issues for Projection Lithography at 157 nm	T. M. Bloomstein M. Rothschild S. T. Palmacci M. W. Horn R. B. Goodman D. E. Hardy	Photomask Japan '98, Kanagawa, Japan, 9-10 April 1998
Cooled Yb:YAG for High-Power Solid-State Lasers	T. Y. Fan T. Crow* B. Hoden* F. Way*	International Symposium on Aerospace/Defense Sensing, Simulation and Controls, Orlando, Florida, 13-17 April 1998
Transmission of RF and Microwave Signals over Optical Fibers	R. C. Williamson	Lincoln Laboratory Technical Seminar Series, University of Wisconsin, Racine, Wisconsin, 27 April 1998
B-Cell-Based Sensors for Rapid Bioagent Identification	M. A. Hollis	American Association of Universities Symposium, Washington, DC, 29 April 1998
MIT Lincoln Laboratory's Microelectronics Laboratory	C. L. Keast	Lincoln Laboratory Technical Seminar Series, Rose-Hulman Institute of Technology, Terre Haute, Indiana, 29 April 1998

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SOLID STATE
DIVISION 8

1. QUANTUM ELECTRONICS

A real-time, point bioaerosol sensor for early warning of threat bioaerosols has been developed, which is based on laser-induced-fluorescence detection of aerosol particles and incorporates two spectral channels for discrimination of threat aerosols from background aerosols. Field tests at Dugway Proving Ground, Utah, in September 1997 showed that the sensor can detect threat bioaerosols at a concentration of 5–10 particles per liter of air and can discriminate threat aerosols from natural background aerosols.

2. ELECTRO–OPTICAL MATERIALS AND DEVICES

Measurements of analog optical links from 0.1 to 20 GHz have been obtained. Their performance with an Nd:YAG laser has been compared to their performance with semiconductor laser and amplifier sources.

Tapered lasers have been fabricated from a GaInAsSb/AlGaAsSb single-quantum-well structure with threshold current densities as low as 50 A/cm^2 at room temperature. These lasers have exhibited diffraction-limited cw output power up to 600 mW.

3. SUBMICROMETER TECHNOLOGY

The effects of laser fluence and pulse count on irradiation-induced compaction of fused silica have been experimentally investigated using a 193-nm excimer laser source. The amount of laser-induced compaction is shown to depend upon both the total dose and dose rate.

4. HIGH SPEED ELECTRONICS

Field emitter arrays for use in inductive output amplifiers have been characterized: process modifications have enabled the fabrication of single- and few-tip arrays, and noise characteristics of such arrays have been obtained. Two schemes for protection against gate-to-tip arc currents have been analyzed and shown to be able to provide arc protection while maintaining the ability to modulate the beam at RF.

5. MICROELECTRONICS

An inhomogeneity in the response to back-surface illuminated charge-coupled devices has been found to be related to laser anneal conditions and the presence of a B interstitial defect. Modifying the ion implantation and laser anneal conditions has eliminated the problem throughout the wavelength and temperature regime of interest.

6. ANALOG DEVICE TECHNOLOGY

The accuracy of 2.0-GHz-bandwidth 20-ns-long high-temperature superconductive (HTS) chirp filters has been improved by more than an order of magnitude. These accurate HTS chirp filters have been used with a microwave chirp generator to produce compressed pulses with error sidelobes down by more than 30 dB from the mainlobe.

7. ADVANCED SILICON TECHNOLOGY

In the development of an integrated CCD/CMOS silicon-on-insulator (SOI) technology, SOITEC Unibond SOI material has been selected as the best suited for high-performance CCDs based on detailed materials and electrical evaluation. In addition, CCD and CMOS processes have been modified for integrated 3.3 V operation and simulations have demonstrated that high-performance 3.3 V CCD operation is possible, and a test reticle set has been designed and the fabrication of the first monolithic low-power CCD/CMOS process begun.

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13. ABSTRACT (*Maximum 200 words*)

This Quarterly Technical Summary covers the period 1 February through 30 April 1998. It consolidates the reports of Division 6 (Communications and Information Technology) and Division 8 (Solid State) on the Advanced Electronics Technology Program.

14. SUBJECT TERMS

digital computers	electro-optic devices	submicrometer technology
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